LEGEND: **DRAFT 10/08/15**
Blue bold text is added from 10 CSR 20-8.020(9)(D).
Green text is added from Iowa.
Brown text is added from Texas Chapter 217-D 2008
Purple text is added from draft 10 CSR 20-8.120 Gravity Sewers.
Red text is added from draft 10 CSR 20-8.130 Pumping Stations.

Title 10 – DEPARTMENT OF NATURAL RESOURCES
Division 20 – Clean Water Commission
Chapter 8 – Design Guides

10 CSR 20-8.125 Alternative Sewer Systems.

PURPOSE: The following criteria have been prepared as a guide for the design of alternative sewers. This rule is to be used with rules 10 CSR 20-8.110 through 10 CSR 20-8.200 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission in regard to adequacy of design, submission of plans, approval of plans, and approval of completed wastewater treatment facilities and collection systems. It is not reasonable or practical to include all aspects of design in these standards. The design engineer should obtain appropriate reference materials which include but are not limited to: copies of all ASTM International standards pertaining to sewers and appurtenances, design manuals such as Water Environment Federation's Manuals of Practice, and other sewer design manuals containing principles of accepted engineering practice. Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. It is anticipated that these criteria will be subject to review and revision periodically as additional information and methods appear.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms "shall" and "must" are used, they are to mean a mandatory requirement insofar as approval by the Missouri Department of Natural Resources (department) is concerned, unless justification is presented for deviation from the requirements. Other terms, such as "should," "recommend," "preferred," and the like, indicate the preference of the department for consideration by the design engineer.

(A) Deviations. Deviations from these rules may be approved by the department when engineering justification satisfactory to the department is provided. Justification must substantially demonstrate in writing and through calculations that a variation(s) from the design rules will result in either at least equivalent or improved effectiveness. Deviations are subject to case-by-case review with individual project consideration.

(B) Alternative Sewer Systems. Alternative sewer systems include pressurized sewers carrying raw wastewater from grinder pumps, pressurized or gravity sewers carrying septic tank effluent, and combinations thereof. Although each alternative collection technology uses different motive forces (pressure, gravity, and vacuum) to move wastewater from its source to its destination, there are many commonalities. All use lightweight plastic pipe buried at shallow depths, with fewer joints due to increased pipe lengths than typical gravity sewers. Alternative sewer systems are generally lower in capital costs than conventional gravity sewers.

(C) Sewer. A pipe or conduit that conveys wastewater or stormwater.

(D) Building Lateral. A building lateral is a pipe or conduit that conveys wastewater from only one (1) building to a point where it is joined to an alternative sewer system unit (i.e.,

grinder pump station and septic tank). Maintenance and ownership of the building lateral is generally the responsibility of the property owner.

(E) Service Line. A service line is a pipe or conduit that conveys wastewater from one (1) alternative sewer system unit (i.e., grinder pump station and septic tank) to a point where it is joined to a sanitary sewer system which is operated and maintained by one (1) of the continuing authorities listed in 10 CSR 20-6.010(3)(B).

(F) Sewer Main. Sewer mains are used to convey wastewater from one (1) or more service lines to conventional gravity sewers, treatment, or other disposal facilities. A sewer main is considered part of a sanitary sewer system that is operated and maintained by one (1) of the continuing authorities listed in 10 CSR 20-6.010(3)(B).

(2) Approval of Sewers. The department will approve plans for new systems, extensions to new areas, or replacement sanitary sewers only when designed upon the separate basis, where rain water from roofs, streets, and other areas and groundwater from foundation drains are excluded.

(3) Design Capacity and Design Flow. Sewer capacity and flow shall be in accordance with 10 CSR 20-8.120(4).

(4) Supplement to the Engineering Report. Alternative sewer systems are not to be used in lieu of conventional gravity sewers, but may be acceptable when it can be shown in the engineering report that it is not feasible to provide conventional gravity sewers. Use of alternative sewer systems should be considered when justified by unusual terrain or geological formations, low population density, difficult construction, or other circumstances where alternative sewer systems would offer an advantage over conventional gravity sewers. Refer to 10 CSR 20-8.110(4)(B) for more information.

(5) General.

(A) Continuing Authority. When alternative sewer systems are utilized, the continuing authority shall be responsible for the operation, maintenance, and modernization of the individual units (i.e., grinder pump stations, septic tanks, and septic tanks pumps) with the exception noted in RSMo Section 249.100. See 10 CSR 20-6.010(3) for acceptable continuing authorities.

(B) Flooding. Wastewater pumping station structures and electrical and mechanical equipment shall be protected from physical damage by not less than one foot (1') (0.3m) above the one hundred (100)-year flood elevation or one foot (1') (0.3m) above the highest historical flood elevation, whichever is higher. Wastewater pumping station structures should remain fully operational and accessible during the twenty-five (25)-year flood.

(C) Accessibility. Pumping station structures and septic tanks shall be readily accessible by maintenance vehicles during all weather conditions. Pumping station structures and septic tanks should be located off the traffic way of streets and alleys.

(D) Security. The design of an alternative sewer system, including all mechanical and electrical equipment, must restrict access by an unauthorized person, discourage vandalism, and prohibit the entrance of animals. It is recommended that electrical control panels and

Comment [ETC1]: RSMo Section 249.100: A publicly owned treatment works that has ownership of interceptor and local sewers shall be responsible for the entire public sewer system, except that the operation and maintenance of any part of the individual user's pressure sewer system, including grinder or low pressure pumps and service lateral to the public or private pressure sewer system used for the purpose of collecting or conducting wastewater originating at a residence or individual commercial entity, shall be the responsibility of the owner of such residence or individual commercial entity unless the publicly owned treatment works has assumed such responsibility.

Comment [ETC2]: Are these return flood levels applicable to alternative sewers?

access hatches with locks be provided. Bolt down lids are recommended for septic tanks. Also refer to 10 CSR 20-8.140(9)(A)1.

(E) Buoyancy. Where high groundwater conditions are anticipated, buoyancy of the piping and wastewater structures shall be considered and, if necessary, adequate provisions shall be made for protection.

(F) Identification. Where sewers are constructed of a material that might cause the sewer to be confused with potable water mains, the sewer shall be appropriately identified.

(G) Locator Wire. Where location wire is utilized, it shall comply with 10 CSR 20-8.120(11).

(H) Sewers in Relation to Streams. The location and construction of sewers in relation to streams shall be in accordance with 10 CSR 20-8.120(8).

(I) Aerial Crossings. Aerial crossings shall comply with 10 CSR 20-8.120(9).

(J) Potable Water Sources. The distance between wastewater pumping station structures and all potable water sources should be one hundred feet (100') (30.5 m) and shall be at least fifty feet (50') (15.2 m) in accordance with 10 CSR 23-3.010(2)(A)5.

(K) Protection of Water Supplies. The relation and crossings of water supplies shall be in accordance with 10 CSR 20-8.120(10).

(L) Safety. Refer to 10 CSR 20-8.140(9) for safety concerns.

(M) Erosion Control During Construction. Effective site erosion control shall be provided during construction. Erosion control activities shall obtain a stormwater permit for land disturbance activities that meet the requirements of the land disturbance permit, in accordance with 10 CSR 20-6.200.

(N) Grading and Landscaping. Upon completion of construction, the ground should be graded and either sodded or seeded. Where possible, steep slopes should be avoided to prevent erosion and to minimize slips, trip, and falls. Surface water shall not be permitted to drain into any pump station.

(O) Odor Control. Provisions for odor control shall be considered in the design of alternative sewer systems.

(6) Pressure Sewers. Pressure sewers consists of a small diameter pipeline, placed at a shallow depth, generally following the profile of the ground, that receives macerated wastewater for conveyance from two (2) or more grinder pump stations.

(A) Sewer Design. Pressure sewer systems shall be laid out in a dendritic pattern (e.g. branched tree configuration). The purpose of the branched layout is to have a predictable minimum self-cleaning velocity in the sewer mains. Also, a section of the piping system may be shut down for repairs without interrupting flow from all upstream inputs.

1. Velocity. The velocity shall be based on the most probable number of grinder pump units expected to operate simultaneously or on some other acceptable method of computing the peak pumpage rate.

A. A cleansing velocity of at least two feet per second (2 ft/s) (0.6 m/s) shall be achieved at least once and preferably several times per day.

B. The maximum velocity in any portion of the system shall be eight feet per second (8 ft/s) (2.4 m/s) without velocity protection and thirteen feet per second (13 ft/s) (4.0 m/s) with velocity protection.

2. Minimum size. The minimum diameter sewer main pipe shall not be less than two inches (2") (5 cm).

3. Cover. All sewers shall be covered with at least thirty-six inches (36") (91 cm) of soil, other insulation, or material to prevent freezing and to protect them from superimposed loads. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

Comment [ETC3]: 36" is consistent with 8.120. However, other states commonly used 30" of cover.

4. Materials. Any generally accepted material for sewers will be given consideration, but the material selected shall be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, corrosion, or similar problems.

A. All sewer pipe and joint materials shall conform to the appropriate ASTM specifications.

B. Suitable couplings complying with ASTM specifications shall be used for joining dissimilar materials.

C. All sewers shall be designed to prevent damage from superimposed live, dead, and frost-induced loads. Proper allowance for loads on the sewer shall be made because of soil and potential groundwater conditions, as well as the width and depth of the trench. Where necessary, special bedding, haunching, initial backfill, concrete cradle, or other special construction shall be used to withstand anticipated superimposed loading or loss of trench wall stability.

D. For new pipe or joint materials for which ASTM standards have not been established, the design engineer shall provide complete material and installation specifications developed on the basis of criteria adequately documented and certified in writing by the manufacturer to be satisfactory for the specific detailed plans for approval by the department.

5. Installation. Refer to 10 CSR 20-8.120(5)(H)1. through 10 CSR 20-8.120(5)(H)4.

6. Termination. The sewer main shall enter the receiving manhole with a smooth flow transition to the gravity sewer system at a point not more than one foot (1') (0.3 m) above the flow line. The design shall minimize turbulence and scouring at the point of discharge. Corrosion protection for the receiving manhole shall be provided in accordance with 10 CSR 20-8.120(6)(H).

7. Design friction losses.

A. Friction coefficient. Friction losses through the sewers shall be based on the Hazen-Williams formula or other acceptable method (e.g. the Darcy-Weisbach equation). When the Hazen-Williams formula is used, the value for "C" shall be one hundred (100) for unlined iron or steel pipe for design. For other smooth pipe materials such as polyvinyl chloride, polyethylene, lined ductile iron, etc., a higher "C" value, not to exceed one hundred thirty (130), may be allowed for design.

B. Maximum power requirements. When initially installed, the sewers will have a significantly higher "C" factor. The effect of the higher "C" factor shall be considered when calculating maximum power requirements and duty cycle time to prevent damage to the motor. The effects of higher discharge rates on selected pumps and downstream facilities shall also be considered.

Comment [ETC4]: Is this applicable to alternative sewers?

8. Leakage testing. Hydrostatic testing shall conform to the test procedures in AWWA C600-64.

9. Pressure testing. Pressure tests shall be made only after the completion of backfilling operations and after the concrete thrust blocks have set for at least thirty-six (36) hours.

A. The duration of the pressure test shall be a minimum of one (1) hour unless otherwise directed by the manufacturer. Test pressure shall be fifty pounds per square inch (50 psi) minimum with a recommended pressure of two and one-half (2 ½) times the maximum system operating pressure.

B. The pipe line shall be slowly filled with water. The specified pressure measured at the lowest point of elevation shall be applied by means of a pump connected to the pipe.

C. During filling of the pipe and before applying the specified pressure, all air shall be expelled from the pipeline by making taps at the point of highest elevation. After completion of the test the taps shall be tightly plugged at the sewer main.

10. Corrosion. Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection of the interior pipe shall be provided.

11. Cleaning. Consideration should be given to providing a suitable method of cleaning the force main whenever the velocity in the force main may be less than two feet per second (2 ft/s) (0.6 m/s) before ultimate development is reached.

(B) Sewer Appurtenances. All appurtenances shall be compatible with the piping system used and shall be full bore with smooth interior surfaces to eliminate obstruction and keep friction loss to a minimum.

1. Isolation valves. Isolation valves are necessary for isolating sections of lines during line breaks or other emergencies.

A. Isolation valves must be—

(I) Resilient seated gate valve or ball valve with a position indicator;

(II) Constructed from corrosion resistant materials; and

(III) Enclosed in a watertight and lockable valve box.

B. Isolation valves shall be installed—

(I) On the upstream side of pipe intersections;

(II) On both sides of stream, bridge, and railroad crossings, and unstable soil;

(III) On the terminal end of the system to facilitate future extensions; and

(IV) At distances not greater than two thousand five hundred feet (2,500') (762 m).

C. The weight of the valve shall not be carried by the pipe. Valves shall be provided with proper support, such as crushed stone, concrete pads, or a well compacted trench bottom.

2. Cleanouts. Accumulation of grease and solids will reduce the pressure sewer system capacity by increasing friction losses. Access to pipeline cleaning is provided by cleanouts.

A. Cleanouts shall be installed—

(I) At the end of each line;

(II) At all changes in pipe size;

Comment [ETC5]: AA comment:
Would change shall to should. He is inclined to require this only on very large regional collection systems. He has been told that cleanouts cause problems by the way they are placed in the system.

Cleanouts can be a source of I/I and sediment entering the system.

(III) At all major changes in direction;
(IV) At all pipe intersections; and
(V) At distances not greater than one thousand feet (1,000') (305 m).

B. A cleanout must be enclosed in a watertight valve box with a locking cap.

C. Cleanouts shall be provided with proper support, such as crushed stone, concrete pads, or a well compacted trench bottom.

3. Air and Vacuum Relief Valve.

A. Air relief valves shall be placed at high points in pressure sewers to prevent air locking. If a line is oversized to allow for gravity flow, an air release valve shall be placed at both the high point and at a point five feet (5') (1.5 m) below the elevation of the downstream static hydraulic grade-line.

B. Vacuum relief valves may be necessary to relieve negative pressures on pressure sewers. The pressure sewer configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.

C. An air or vacuum relief valve should have an isolation valve between the air relief valve and the pressure sewer.

D. An air or vacuum relief valve must be constructed from corrosion resistant materials.

E. An air or vacuum relief valve must be inside a vault that is at least forty eight inches (48") (1.2 m) in diameter and has an access opening at least thirty inches (30") (0.76 m) in diameter. The vault shall have provisions for air displacement to the atmosphere, such as an inverted and screened "j" tube or other means.

F. A pressure sewer should have valves spaced at no more than one thousand five hundred foot (1,500') (457.2 m) intervals to facilitate initial testing and subsequent maintenance and repairs.

G. The weight of the valve shall not be carried by the pipe. Valves shall be provided with proper support, such as crushed stone, concrete pads, or a well compacted trench bottom.

4. Anchoring. Pressure sewers shall be sufficiently anchored within the grinder pump stations and throughout the line length. The number of bends shall be as few as possible. Thrust blocks, restrained joints, and/or tie rods shall be provided where restraint is needed.

5. Flow meters. Flow meters are recommended to obtain individual branch flow information. At a minimum, permanent access shall be provided in each branch to facilitate temporary flow metering.

6. Pressure monitoring stations. Pressure monitoring stations shall be provided to allow access to measure and record system pressure. Pressure monitoring stations could identify areas where air-induced headloss may be occurring. Pressure monitoring stations shall consist of an access vault to the collection piping, including a threaded tap and pressure gauge.

(C) Service Line Connection.

1. Service connections to the pressure sewer main shall be watertight and shall not protrude into the sewer.

Comment [ETC6]: 8.020(9)(D)6:
In place of manholes normally provided in gravity systems, pressure systems shall have cleanouts at intervals of approximately four hundred to five hundred feet (400–500'), at major changes of direction and where one (1) collector main joins another main.

Comment [ETC7]: Should this requirement be limited to only larger systems? What is considered a large system?

2. If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected.
3. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.
4. The minimum diameter service line pipe shall not be less than one and one quarter inches (1.25") (3.2 cm).
5. A check valve and isolation valve shall be installed on each service line. Refer to paragraph (6)(B)1. of this rule for more information.

(D) Grinder Pump Stations.

1. Type. Both stable-curve centrifugal and progressing cavity semipositive displacement pumps may be used in pressure sewer systems. The stable-curve centrifugal, a pump having a maximum head at no flow, may be considered for its ability to compensate with reduced or zero delivery against excessive high pressures and the ability to deliver at a high rate during low flow situations in the system, thus enhancing scouring during low flow periods. The progressing cavity semipositive displacement pump may be considered for its relatively constant rate of delivery in situations in which this feature is considered necessary. The semipositive displacement pump has no significant increases in delivery against low-flow system conditions to enhance scour during minimum flow times.
2. Number of pumps. A simplex grinder pump station shall serve no more than one (1) platted lot. A grinder pump station serving more than one (1) platted lot must consist of two (2) pumps of the same size and shall have the capacity that, with any pump out-of-service, the remaining pump will have capacity to handle the design peak hourly flow. A grinder pump station serving multiple platted lots must be owned, operated, and maintained by an acceptable continuing authority listed in 10 CSR 20-6.010(3).
3. Location. A grinder pump station shall be located outdoors and in sight of the structure it is serving with consideration given to future maintenance accessibility.
4. Construction materials.
   A. Grinder pump vaults are typically constructed from fiberglass reinforced polyester, high density polyethylene, steel, or concrete.
   B. All pipes and appurtenances within a grinder pump station must be corrosion resistant. For metal components, austenitic stainless steel of type 316 or 304 shall be provided at a minimum. Nylon is degraded by hydrogen sulfide and is not acceptable.
   C. Contact between dissimilar metals should be avoided or other provisions made to minimize galvanic action.
5. Grinder pump vaults shall be gas and watertight.
6. Access. A minimum access diameter of twenty-four inches (24") (61 cm) shall be provided for simplex grinder pump vaults. Duplex grinder pump vaults must have a minimum access diameter of forty-eight inches (48") (122 cm).
7. Vault cover. Bolt-down cover assemblies or locked covers shall be provided.
8. Ventilation. All grinder pump vaults shall have provisions for air displacement to the atmosphere, such as an inverted and screened "j" tube or other means.
9. Storage volume. A simplex grinder pump vault must have a storage volume of at least fifty (50) gallons (189 L) after the activation of the high water alarm level. The storage

Comment [ETC8]: AA comment:
We should keep the threshold in 10 CSR 20-8.020(10)(A)3:

Single pump installations may be given consideration only for very small installations, where average daily flows are less than fifteen hundred (1500) gallons per day, and only if the station is designed to permit the installation of a future duplicate unit without structural change and satisfactory means are provided to detect malfunctions and take corrective actions before an overflow to waters of the state could occur.

This would result in up to 3-4 homes connected to a simplex grinder pump station.

Comment [ETC9]: 8.130 currently:
The minimum storage capacity of the grinder pump unit shall be fifty (50) gallons (189 l). The unit shall be capable of accommodating normal peak flows for periods of eight to twelve (8-12) hours.

volume of a duplex grinder pump vault must equal the volume accumulated during an average two (2)-hour period or fifty (50) gallons (189 L), whichever is greater.

10. Pump removal. Grinder pumps shall be readily removable and replaceable without personnel entering or dewatering the grinder pump station or disconnecting any piping in the grinder pump vault.

11. Valves. The following valves must be provided in the grinder pump vaults:
    A. A shutoff valve accessible from the ground surface;
    B. A check valve to prevent backflow; and
    C. An anti-siphon valve, if siphoning could occur.

12. Grinder pump construction. Grinder pumps shall be designed specifically for raw wastewater use, including totally submerged operation during a portion of each pumping cycle, and shall meet the requirements of the NEC for such units.

13. Pump openings. The grinder unit must be capable of reducing any material which enters the grinder unit to a size that the materials will pass through the pump unit and pressure sewer system without plugging or clogging. No screens or other devices requiring regular maintenance may be used to keep trashy or stringy material out of the grinder pump or sewer main.

14. Controls. Water level controls sensing devices should be located to prevent undue affects from turbulent flows entering the grinder pump station or by the turbulent suction of the pumps. Water level controls must be accessible without entering the grinder pump station. Provision shall be made to automatically alternate the pumps in use for duplex grinder pump stations.

15. Electrical equipment. Electrical equipment shall be in accordance with 10 CSR 20-8.130(6)(D).

16. Flow measurement. All grinder pump stations shall be equipped with elapsed time meters at a minimum provided sufficient metering is configured to measure the duration of individual and simultaneous pump operation.

17. Alarm systems. Alarm systems with a backup power source shall be provided for all grinder pump stations. The alarm shall be activated in cases of power failure, high water levels, pump failure, or any other cause of grinder pump station malfunction. Audio-visual alarm systems shall be provided at a minimum. A sign shall be posted at each grinder pump station in a clearly visible location, listing a telephone number to be called if the alarm is seen or heard.

18. Emergency operations. Provisions must be made for periods of mechanical or power failure. Alternatives are as follows:
    A. Depend upon built-in storage of tank and associated gravity piping;
    B. Provide additional storage capacity where power outages occur frequently (twenty-four (24)-hour storage capacity is recommended); or
    C. Provide a portable generator or pump to connect to each grinder pump station for a short term during an extended outage.

19. Spare parts. An inventory of five percent (5%) of the number of grinder pumps in operation for each model installed must be provided. All working parts of the grinder pump stations should be on hand in sufficient quantity.

Comment [ETC10]: Should we require an average response time which would affect the amount of storage volume required?

(7) Septic Tank Effluent Pumped (STEP) Sewers.
(A) Sewer Design. Refer to subsection (6)(A) of this rule.
(B) Sewer Appurtenances. Refer to subsection (6)(B) of this rule.
(C) Service Line Connection. Refer to subsection (6)(C) of this rule.
(D) Septic Tank Design.

(8) Septic Tank Effluent Gravity (STEG) Sewers.

(9) Vacuum Sewers. Vacuum sewers shall be evaluated on a case-by-case basis. Design standards, operating data, and experience for this system is not well established in Missouri.

(10) Supplement to Summary of Design. The summary of design shall contain the following information in addition to that required in 10 CSR 20-8.110(5).
(A) Pressure Sewers. The following must be included for pressure sewer systems:
1. Hydraulic loadings including the design average flow and the design peak hourly flow;
2. Pipe size, material, type or class, and length;
3. Velocity calculations for each pipe segment;
4. The elevation of the hydraulic grade-line and ground elevation at peak hourly flow for each pipe segment;
5. Calculated design friction losses;
6. Number and location of stream crossings;
7. Number of isolation valves, cleanouts, and air and vacuum relief valves;
8. Number of simplex and duplex grinder pump stations;
9. Calculations showing that grinder pump stations are protected against buoyancy forces;
10. Static head;
11. Total dynamic head;
12. Selected pump manufacturer's information including the model number, type, horsepower, speed in revolutions per minute, voltage, and phase;
13. Pump capacity in gallons per minute;
14. Performance curves for each pump with the system curve plotted and the pump's operating point marked.
15. Cycle times based on design average flow and design peak hourly flow; and
16. Method of emergency operations.
(B) STEP Sewers.
(C) STEG Sewers.